13. On two new Elasmobranch Fishes (*Crossorhinus jurassicus*, sp. nov., and *Protospinax annectans*, gen. et sp. nov.) from the Upper Jurassic Lithographic Stone of Bavaria.

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(Plate I.)

Most of the modern groups of Elasmobranch fishes seem to have arisen during the Cretaceous period, but some are of still older date, and a few interesting types are represented by well-preserved fossils in the Upper Jurassic lithographic stone of Bavaria, Würtemberg, and France. Two remarkable new examples of these early forerunners of the existing fauna have lately been identified in the British Museum, one apparently indistinguishable from an existing genus, *Crossorhinus* (or *Orectolobus*), the other evidently of a new genus and family closely related to the Spinacidæ.

Family CROSSORHINIDÆ.

Crossorhinus jurassicus, sp. n. (Pl. I. fig. 1.)

Specific Characters.—Head gently rounded in front; length of head and trunk about equal to that of the tail. Three pairs of fringing dermal lappets, all undivided, the first extending along the sides of the front half of the head, the next pair diminutive, and the third pair largest, extending along the sides of the branchial region. Pectoral fins rounded, relatively large, extending nearly as far back as the origin of the pelvic fins, which are also rounded and about two-thirds as wide as the pectorals. Dorsal fins rather small and apparently nearly equal in size; the first dorsal arising opposite the hinder limit of the pelvic fins; the second ending in advance of the much smaller anal fin, which is close to the lower lobe of the caudal. Body and fins covered with very fine shagreen, of which some granules between the pectoral fins have a fluted sculpture.

Description of Type Specimen.—The fossil, which is shown of the natural size in Pl. I. fig. 1, is exposed in its anterior half from below, in its caudal half from the side. The snout is short and bluntly rounded, and the rami of the jaws are vaguely seen, meeting in an acute angle at the symphysis, where there are remains of a cluster of very slender, smooth, pointed teeth. The branchial region is relatively long, but the branchial arches are even more obscured by the crushed shagreen than the jaws. A single

pair of large dermal lappets (III), widest in front and gradually narrowing backwards, extends along the whole length of the branchial region. Another pair of minute simple lappets (II) is well seen just in front of this, and the mode of staining of the fossil suggests that there is a long and narrow fringe of skin (I) along each side of the rostral region. The vertebral centra are much constricted and smooth, but where broken they seem to exhibit traces of some secondary calcification round the primitive double-cone. Their arches are not distinguishable, but the comparative shortness of the centra in the front part of the caudal region evidently results from diplospondyly. The large pectoral fins are remarkably rounded, slightly longer than wide, and the stout basal cartilages do not extend more than half-way towards the distal margin. The long unjointed proximal radial cartilages are well seen in the left pectoral. The tapering ascending parts of the pectoral arch are crushed backwards. The pelvic fins, which are much longer than wide, are supported in their basal half by very stout radial cartilages ranged along the basipterygium, which is not produced into claspers. The individual represented is therefore female. The two dorsal fins are crushed downwards to the left side of the fossil, and seem to have been nearly equal in size; but the parts projecting beyond the edge of the tail probably represent only their apical halves. The first dorsal, which is rather fragmentary, arises just behind the end of the pelvic fins, while the second must have been completely in advance of the anal. The anal fin is relatively small, short, and rounded, and close to the lower lobe of the much extended caudal fin. The lower lobe of the latter is clearly notched near its distal end. The head, trunk, and fins are completely covered with very fine shagreen. Most of the granules appear to be flat and smooth, but some are pointed, and a few on the back of the trunk between the pectoral fins are both pointed and slightly enlarged and coarsely fluted.

Affinities.—So far as preserved, there is nothing in the fossil thus described to separate it from the existing genus *Crossorhinus*, but it is distinguished from all known species* by the simplicity of the dermal lappets fringing the head, and by the relatively large size of the pectoral fins.

Family PROTOSPINACIDÆ, nov.

Body depressed, but base of pectoral fins not produced forwards. Vertebral centra well calcified (probably tectospondylic). Radial cartilages of paired fins not extending to the margin; two dorsal fins on the tail, each with an anterior spine; anal fin present.

* Compare C. Tate Regan, P. Z. S. 1908. pp. 354–357, pl. xi. fig. 2, pl. xii. fig. 2; also Ann. & Mag. Nat. Hist. [8] vol. iii. (1909), p. 529. J. Douglas Ogilby & A. R. McCulloch, Journ. Roy. Soc. N. S. Wales, vol. xlii. (1908), pp. 269–280, pl. xlii., pl. xliii. fig. 1. For skeleton see also W. A. Haswell, Proc. Linn. Soc. N. S. Wales, vol. ix. (1884), pp. 92–98, pl. i. figs. 6–8, pl. ii. fig. 13.

Genus Protospinax, nov.

Snout short and obtusely rounded. Teeth small, compressed to a sharp edge. Pectoral fins extending as far backwards as the pelvic pair; dorsal fin-spines large, laterally compressed, and smooth, the first inserted opposite the pelvic fins; anal fin very small, close to the elongate-ovoid caudal, which is not notched. Shagreen dense and fine, none enlarged; lateral line supported by a series of calcified ringlets.

Protospinax annectans, sp. n. (Pl. I. figs. 2, 3.)

Specific Characters.—Attaining a length of about a metre. Length of cranium slightly less than one-fifth, length of caudal fin about one-sixth of the total length. Teeth smooth and lozenge-shaped, their sharp-edged crown sometimes with a prominent middle point. Antero-posterior measurement of pectoral fin about equal to the length of the cranium, and nearly twice as great as the length of the pelvic basipterygium. Dorsal fins about equal in size, the first arising slightly in advance of the middle of the fish.

Description of Type Specimen.—The fossil, which is shown of one-sixth the natural size in Pl. I. fig. 2, is very fragmentary, but there are definite points of contact between the pieces of rock in which it is contained, and most of it is preserved in counterpart, so that its general shape and proportions are recognisable. The head and trunk are seen directly from above, while the greater part of the tail is exposed in side-view. The edges of the head and fins are sharply outlined by fine dense shagreen, while the distinctness of part of the margin of the caudal region is due to fossilised muscle. The cranium is well calcified in the usual small tesseræ, and evidently not much distorted. Its postorbital part is about as broad as long, and the postorbital processes are small and slender. There is very little constriction between the orbits, which are completely within the hinder half of the cranium. The olfactory capsules form relatively large rounded lateral prominences in the middle of the cranium. The rostral part is short and wide, not tapering but nearly truncated in front, and remarkable for the large size of the elongated anterior fontanelle which extends backwards between the olfactory capsules. There is no indication of a posterior fontanelle in the cranial roof. The jaws are not seen, but there appears to be a vague trace of the mandibular articulation on the right side well behind the occiput. All the vertebræ are crushed and broken, but they show much secondary calcification round the primary double-cone, and this seems to have been in concentric laminæ (on the tectospondylic plan). As in many other fossil Elasmobranchs from the lithographic stone, the body-muscles are well preserved; and it is clear that while in the abdominal region each myotome corresponds with one vertebral centrum, in the anterior part of the caudal region each myotome comprises two

vertebral centra. There is thus the common diplospondyly. The vertebral arches are scarcely seen, except within the caudal fin, which is displayed in direct side-view. Here the hæmals are apparently stouter and less inclined backwards than the neurals. The pectoral arch is only imperfectly shown, but the right pectoral fin is complete. It is relatively large, and the supporting cartilages extend only about half-way from its insertion towards the distal margin. The three basals are distinct, the propterygium being comparatively small and narrow, the triangular mesopterygium about as wide as long, and the metapterygium longer than wide but very little produced backwards. The radial cartilages, which are not much longer than the basals, are rather sparsely arranged and do not clearly exhibit any transverse articulations. About 12 are arranged along both the mesopterygium and the metapterygium. Faint striations are seen in part of the fin-membrane, but there are no distinct remains of dermal rays. The pectoral fins extend as far backwards as the pelvic fins, which are much smaller. The pelvic basipterygium is long and gradually tapering, and bears at least 17 radial cartilages, which (like those of the pectoral) are not closely pressed together and do not show any transverse articulations. The cartilages occupy only half of the total expanse of the fin. As they are imperfect behind, the sex of the individual is uncertain. Of the median fins, one large dorsal, bordered in front by the remains of a smooth, laterally compressed spine (d^1), arises just behind the origin of the pelvic fins; but it is very imperfectly preserved. The impression of the fin-membrane shows some fine striations, which may perhaps denote strengthening dermal rays. As the tail of the fish is relatively long, this is doubtless the first dorsal fin, but the fossil is too fragmentary to exhibit the second dorsal. The caudal fin, which is displayed in direct side-view and only incomplete at the upper extremity, is long and ovoid, with the lower lobe the larger. The membrane here again shows faintly some fine striation. Just in advance of its lower lobe, a small deep and narrow fin is shown (*a.*), with most of the outline defined by oxide of manganese. Though its separation from the caudal is a little obscured by the rough fracture of the rock, it is almost certainly distinct and may be regarded as an anal fin. Fine shagreen covers the whole of the trunk and fins. Near the margins it is especially smooth and dense, but on parts of the trunk the granules are rather stellate. On the trunk in front of the pectoral fins, and again on the tail just behind the pelvic fins, it is interesting to notice that the course of the lateral line is marked by a close series of incomplete ringlets (fig. 2*a*), as in Chimæroids and in the extinct dog-fish, *Mesiteia.*

Young Specimen.—A second specimen in the British Museum (No. 37014), from the same formation and locality, only 30 cm. in length, evidently represents a young individual of the same species. The cranium and vertebral column are in undisturbed series, with the two dorsal fin-spines in their natural position on

the tail; but the parts of the paired fins are scattered, and only fragments remain. The specimen, however, is of special importance, because displaced portions of both jaws with groups of the teeth are also preserved. The characteristic large anterior fontanelle in the cranium is well displayed as in the type specimen. The teeth (fig. 3) are relatively small and closely arranged, several series evidently functional at one time. Their exact shape is difficult to determine, but they seem to be transversely elongated rhomboids, with a low crown, which is smooth, compressed anteroposteriorly to a sharp edge, and sometimes rising in the middle to a little cusp. Many of the vertebral centra clearly exhibit the secondary calcification round the primary double-cone. A fragment of a pelvic fin seems to denote a male individual, and a row of slightly enlarged, pointed shagreen-granules may have belonged to the clasper. The two dorsal fin-spines (fig. 3*a*, d^1, d^2), though fractured, are shown to be nearly similar in size and shape, and their length equals about one-quarter of the distance between their insertions. The spine of the first dorsal is supported not only by a short triangular cartilage behind, but also by a larger and more extended cartilage in front. Traces of the fine stellate shagreen are seen on the rostrum.

Affinities.—The new genus and species now described evidently represent a family closely related to the Spinacidæ, but still retaining the anal fin and a less specialised dentition. *Protospinax* is indeed a generalised type such as might be expected among Jurassic Elasmobranchs when the Batoids were beginning to be differentiated. The Batoids themselves were first represented by the Rhinobatidæ, and it is interesting to notice that one member of this family (*Belemnobatis*) contemporary with *Protospinax* had a spine in front of each of its two dorsal fins.

EXPLANATION OF PLATE I.

Fig. 1. *Crossorhinus jurassicus*, sp. n.; nearly complete fish, nat. size.—Lithographic Stone; Eichstädt, Bavaria. I, II, III. the three paired dermal lappets. [British Museum no. P. 11211.]

2. *Protospinax annectans*, gen. et sp. n.; fragmentary fish, one-sixth nat. size.—Ibid. *a*. anal fin; d^1. spine of first dorsal fin. [British Museum no. P. 8775.]

2*a*. Ditto; portion of lateral line of same specimen enlarged four times to show supporting ringlets.

3. Ditto; group of teeth enlarged ten times.—Ibid. [British Museum no. 37014.]

3*a*. Ditto; portion of tail of same specimen, showing dorsal fin-spines (d^1, d^2), nat. size.